631

Lee B 120

THE RECLAMATION OF A MOUNTAIN SWAMP.

By Marsden Manson, Member of the Technical Society of the Pacific Coast.

[Read before the Spring Meeting of the Society, May 27, 1904.]

[Note.—The execution of this work has been very actively and ably carried out by Mr. Ralph E. Parker. He has made all surveys, and has laid out and constructed the main canal and irrigation ditches and the temporary and movable dams. The writer is indebted to him for the data concerning construction and cost.]

The features with which this paper deals lie in Harney County, Southeastern Oregon, and in the broken and upheaved southern portion of the Columbia Lava Plain. This lava plain has been elsewhere described by the writer (*American Geologist,* Vol. XXIV, 1899, pages 203-209). It covers large areas in Washington, Oregon, California, Wyoming, Idaho and Nevada, and dominates the physical geography and topography of over 150,000 square miles in these States.

The drainage areas and swamp with which we have to deal cover about 450 square miles of a block of lava some 1000 square miles in area, and from 1 to 1¼ miles thick. This broken, tilted and distorted block lies between 2 nearly parallel faults some 25 miles apart and over 40 miles long. The upthrust along the easterly fault is apparently 1 mile or 1¼ miles, and constitutes the bold feature known as Stein Mountain, which reaches an elevation of 11,000 feet above sea level. The easterly slope of this mountain shows a broken and precipitous front, rising above the general level about 1 mile or 1¼ miles, and showing that the lava has approximately this thickness. The westerly slope is a gentle descent of about 5°, partly dissected by rifts and gorges in the lava, and terminating in low bluffs of basaltic lava bordering the easterly side of Blitzen Swamp and rising a few hundred feet above its level. On the westerly border of this swamp and marking the position of the westerly fault plane is another bold escarpment, locally known as "Jackass Rim Rocks," where the vertical movement has probably been 800 to 1000 feet.

Donner and Blitzen Rivers and several minor streams drain about 400 square miles of the west slope of Stein Mountain. In their upper reaches they occupy deep gorges, in which snow drifts and packs in the winter. Snow also accumulates in the thickets of dwarf aspen which grow wherever the soil is deep enough to give roothold. The precipitation upon this drainage area amounts to about 15 inches per year, mostly in the form of snow. Rapid melting in the spring and early summer causes the floods which reach

Blitzen Swamp. Low-water discharge is furnished by springs in the gulches. Accurate hydrometric data were not available, and as the projected reclamation contemplated the use of the swamp lands for raising hardy forage grasses for hay and pasture, short periods of flooding could do no harm. The features above mentioned are given an outline expression in the accompanying sketch map and general sections.

BLITZEN SWAMP.

Blitzen Swamp thus lies in the valley depressed between these 2 basaltic rim rocks, and extends into the lower ends of their lateral gorges. The total area is about 50 square miles, having a length of 22 miles and a mean width of 2.5 miles, and an elevation of about 4500 feet above sea level. The entire valley is about 32 miles long. The swamp is naturally divided into 4 sections—*the Upper Swamp, the Gorge, the Lower Swamp* and *Diamond Swamp,* the latter being an extension into a gorge on the easterly rim rock or lava escarpment.

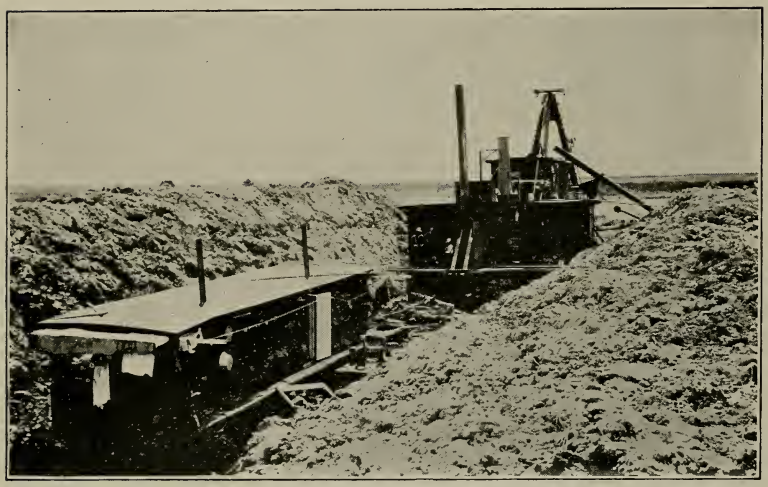
The fall through this valley is not regular, and in the aggregate amounts to 95 feet, 35 feet of this fall being in the upper 7 miles, 25.8 feet in the canalized portion and the remainder in the river to Malheur Lake. The surface of the valley presents all stages of the process of development: (1) Cones of cobble and gravel merging into alluvial lands overgrown with brush. (2) Tule, flag and canebrake swamps, with peat soil resting on a peaty, loam or clay subsoil. (3) Floating islands or "blankets" of peat, on which tules, flags and aquatic plants flourish. (4) Ponds and lakes deeper than the level of proposed drainage. Irregular channels meander through the entire area. In some instances these channels were concealed beneath floating blankets of peat. These blankets were cut up with hay knives and dragged ashore.

The upper portion of the upper swamp has received sufficient sediment to give it steeper gradients, and has been partially cleared and drained and converted into very valuable hay and meadow lands, which are well irrigated. It is not proposed to extend the canal into these lands, as the natural channels have already been improved by scraping them out and by rough rectifications. The main canal will intercept these channels about the middle of the upper swamp. The remainder of the swamp is principally a vast tule swamp, with peat soil and a peaty or clay subsoil.

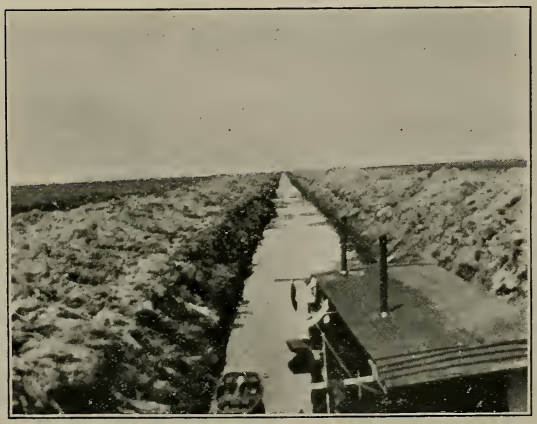
These features are made clearer by the accompanying map, sections and illustrations.

At the lower end of the swamp the basaltic blocks or rim rocks

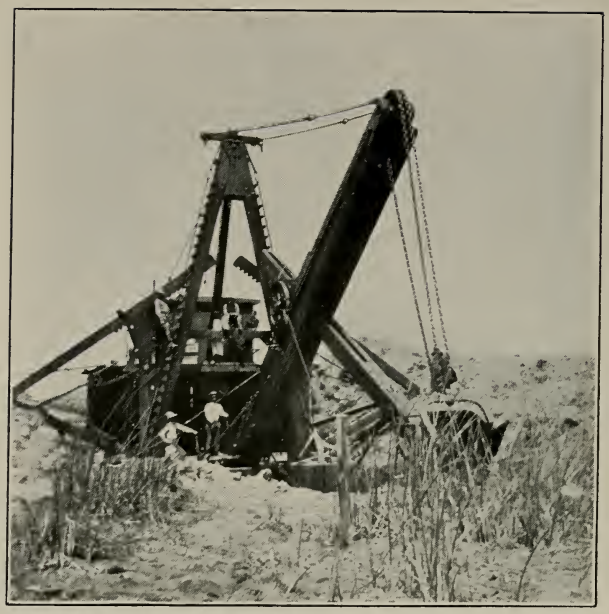
Busse Irrigation Ditch under Construction.



Dredger "Blitzen" and Ark.



Main Canal, Looking Down from Dredger.



Front View of Dredger, Middle Swamp.

Middle Swamp.

fall back and inclose low, flat benches of arid land covered with sagebrush, and aggregating some 15 or more square miles. Over about 12 square miles of this land it is possible to divert water for irrigation.

The writer was called upon to advise as to the possibilities of drainage, the size and location of canals, the type and power of machinery to use and the possible diversion of the drainage waters for irrigation. The problem presented interesting and important features:

First. The drainage of an elevated swamp of considerable area and restricted outfall.

Second. The control of this drainage so as to give broad or subsurface irrigation over the drained area.

Third. The use of the drained-off waters for the irrigation of arid land. This feature was of high importance, by reason of the partial reclamation of the lands bordering Malheur Lake, at the outfall of the Blitzen Swamp. The natural disposition of the spring and early summer floods was principally by evaporation from the 50 square miles of swamp surface.

After an examination of the field of operations and of all data available the summary of the report to the owners was that:

(1) The drainage of the greater portion of the swamp was practicable with a well-aligned main drainage canal having the general fall of the swamp and a sectional area of 260 square feet, but that for short periods of excessive flood partial submergence would occur; that such auxiliary canals as might be found necessary might be considered after the construction of the main canal.

(2) That the waters drained from the swamp should so far as possible be used for the irrigation of the arid lands bordering the lower swamp.

(3) That the best type of dredger to be used was a dipper dredge, with a bucket $1\frac{1}{4}$ cubic yards capacity and a delivery 45 to 50 feet from the center of the canal, the following details of machinery, etc.: Fifty horse-power boiler, locomotive type, 44 inches x 11 feet, large firebox and doors (woodburner). Two engines, 10 inches x 12 inches, for operating crane, 7 small auxiliary engines for hoisting spuds, etc.

Maximum weights were as follows: Crane 8 tons in 3 parts, $2\frac{2}{3}$ tons each.

Boiler, naked, 7000 pounds. Other parts easily handled. (These parts had to be hauled about 200 miles.)

The hull was designed to be 24 feet x 75 feet x 6 feet, but was reduced to 19 feet x 75 feet x 6 feet. As lumber had to be hauled

60 miles from the Blue Mountain Mills, detailed bills of lumber were made out, and equal care and economy were necessary in all ironwork.

The estimated capacity of this plant was as follows:

Under ordinary conditions, 30 linear yards per day of channel, 3 yards deep, 8 yards wide slopes $\frac{1}{4}$, or about $\frac{1}{3}$ mile per month.

Under favorable conditions, 55 linear yards per day, or nearly $\frac{2}{3}$ mile per month, or the entire 13.2 miles of canal in 24 months' work.

It was recommended that where the conditions permitted, that the swamp be cross-sectioned 1000 feet apart, and the canal line located along the lowest ground and most direct alignment, and the ground sounded particularly in the "Narrows," to avoid possible cutting into submerged masses of lava.

The cost of machinery and hull was estimated at $9750, to which was added freight to Winnemucca, hauling to the site an ark or quarter boat and 2 wood scows, costing $8200, as follows:

Freight from Marion, Ohio	$2,100.00
Hauling from Winnemucca	1,200.00
Cost of ark, wood scows, etc.	4,900.00
	$8,200.00
Estimated cost of machinery and hull, as above	9,750.00
Bringing cost of outfit to	$17,950.00

The ark and wood scows are 9 feet x 36 feet x 2 feet.

Force required:

One engineer, 1 fireman, 2 deck hands and 1 cook.

Together with such woodchoppers, teams and drivers as might be found necessary to supply fuel.

Fuel, 2 to 3 cords of wood per day, according to quality—sagebrush could be used.

The surveys were conducted by Mr. Parker, mostly in the winter, when the swamp was frozen over. The tules, flags, etc., are frequently 12 to 14 feet high, so that a mowing machine or drags drawn by horses were used to clear the lines. The surveys occupied 200 days, and cost about $1700, and were completed in the spring of 1902.

The dredger hull and barges were about 2½ months in constructing, and were completed and ready to operate by the middle of April, 1902, and cost practically as estimated.

During the spring and summer of 1902 a little over a month's dredging was done, when the operations were stopped by low water and to complete surveys. Work was resumed in November, 1902, and has progressed regularly to date, with the exception of about 5 months of severe freezing weather.

The canal has been constructed from the lower end of the swamp to the upper part of the gorge, a distance of 7.6 miles.

RESULTS, COST, ETC.

These are best measured by the work of 1903. During that year the total working time was 199½ days of 10 hours.

Canal excavated 24,700 feet, or 222,000 cubic yards. Average per day 123.8 feet, or 1100 cubic yards; average per month of 26 days 0.6 mile.

Wood burned, 500 cords	$2,350.00
Labor	2,800.00
Board of employees	800.00
Oil and waste	150.00
Repairs and replacing worn parts	500.00
Total	$6,600.00

Or 27 cents per linear foot of canal; 3 cents per cubic yard.

Charging up one-quarter of the cost of the plant as a sinking fund to one-half of the work, the cost has beeen 4.12 cents per cubic yard. A clam-shell dredge might have given slightly better results in much of this work, but a portion of the bottom material is too hard to be economically handled by this type of machine, which fact ruled in the selection of the dipper dredge.

Fuel in the form of sagebrush or of dwarf juniper was available. The cost of delivery was about the same, but the labor of firing greater in the case of sagebrush—2 cords being about equivalent to 1 of juniper. Juniper wood was hauled 6 to 7 miles and sometimes rehandled; it cost from $4.70 to $3.10 per cord, and has an efficiency greater than pine. The consumption has been at the rate of about 2½ cords per day, or 108 cords per mile of canal; in the peaty subsoil this consumption drops to 70 or 80 cords.

SUMMARY OF RESULTS.

Over ½ or 7.6 miles of canal are completed—25 square miles of the swamp have been drained; 15 square miles of this area are in use, and can be flooded by the use of movable dams in the canal.

The Busse irrigating ditch has been constructed for 10 miles and nearly 6 square miles of arid land brought under irrigation.

The remainder of the canal, about 5.6 miles in length, is being constructed at the rate of over ½ mile per month; and, unless unexpected interruptions occur, will be completed in 12 working months. The West Side irrigation canal will have to be constructed during this period. It will bring under irrigation 6 square miles more of arid sagebrush land.

The necessity of this use of the drained-off water for irrigation has been previously pointed out; a brief recital of the conditions and work done under this requirement will now be made.

The ultimate drainage of the swamp reaches Malheur Lake; around its edges and upon the lower reaches of the river there are reclaimed lands. But, as previously mentioned, the greater portion of the discharge of Blitzen River was naturally taken up by evaporation from the 50 square miles of swamp surface. To drain this quickly down upon pasture and hay lands would provoke suits for damages; hence the irrigation of the sagebrush lands bordering the lower swamp became not only advisable, but obligatory.

The area over which irrigation can be readily extended is about 12 square miles. Nearly one-half of this has been brought under irrigation by the Busse Ditch, on the easterly side of the Blitzen Swamp. This ditch is 10 miles long, and was constructed with plows and drag scrapers. The various sections of a mile each were proportioned to the area to be served by each, as follows:

	Capacity Sec. Ft.	Width at Bottom, Feet.	Depth of Water, Feet.	Grade, Ft. per Mile.	Area to be Served, Rate of 1 Sec. Ft. per 50 Acres.
1	73.5	25.0	3.25	0.75	3,676
2	72.1	25.0	3.0	0.75	3,607
3	68.9	25.0	3.0	0.75	3,446
4	63.8	22.0	3.0	0.75	3,190
5	60.0	20.0	3.0	0.75	3,002
6	48.5	17.0	2.8	1.00	2,424
7	37.9	12.8	2.5	2.00	1,897
8	20.6	6.0	2.0	2.50	1,029
9	7.1	3.0	1.5	3.50	355
10	1.2	ditch constructed with a plow		4.25	62

The general character and mode of constructing this ditch are shown in the illustration.

The satisfactory results obtained in this work are largely due to the fact that the work was a unit, entirely in the hands of the engineers. The work was carried out according to a general plan, without the intervention of boards of trustees and self-constituted critics and advisors, and without regard to its political effect. If the far grander problems in the lower reaches of the Sacramento and San Joaquin Rivers and elsewhere could be attacked under the same conditions, equally good results could be obtained.

NOTE.—Since the above was written Mr. Parker reports for May:

Days under steam	27	
Days run	26½	
Total distance dredged	6,000	feet.
Dredged per day's run	226	"
Total wood burnt	75	cords.
Wood burnt per day under steam	2.8	"
Wood burnt per 100 feet dredged	1¼	"
Cubic yards moved	41,000	

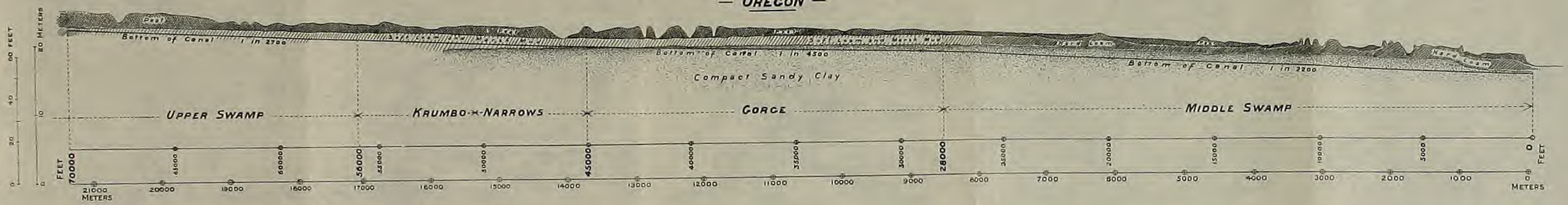
Labor and Expenses.

Crew, including cook, etc.	$380.00
Repairs	10.00
Lubricants	25.00
Hauling wood	200.00
Cutting "	113.00
Total	$823.00

Or about 2 cents per cubic yard.

In reply to an inquiry by Mr. Molera, the author would say that the dredger attacked clay, sand and packed gravel with considerable ease. Those strata are shown in the profile that accompanies the work, and the bottom of the canal in places goes down into compact sandy clay, which is not quite so hard as our hard pan, though if the dredger could once get a start under the edge of hard pan it would easily attack it; and that was one of the main conditions that ruled in the selection of a dipper dredge. The clam shell would not economically attack the harder class of material here dealt with.

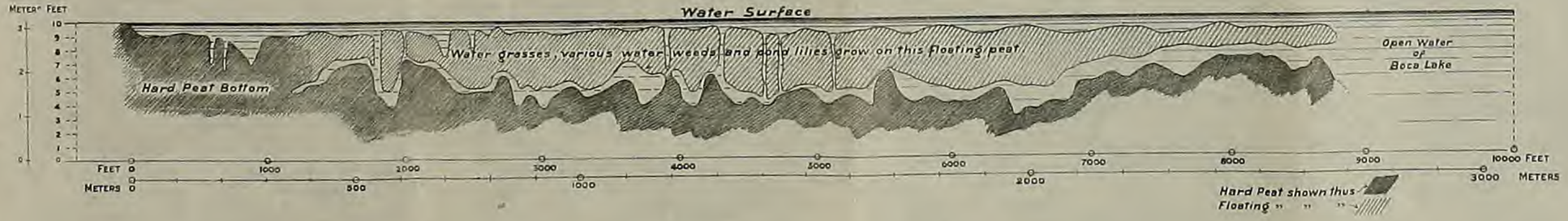
— PROFILE OF DRAINAGE CANAL —
— BLITZEN SWAMP —
— OREGON —



E-W CROSS SECTION, UPPER SWAMP.

(2000 FT. SOUTH OF STA. 700)

[Section selected to show floating peat]


METERS
FEET
Water Surface
Water grasses, various water weeds and pond lilies grow on this floating peat
Hard Peat Bottom
Open Water of Boca Lake
FEET 0 1000 2000 3000 4000 5000 6000 7000 8000 9000 10000 FEET
METERS 0 500 1000 2000 3000 METERS
Hard Peat shown thus
Floating " " "

UPPER SWAMP

GENERAL SECTION SHOWING FORMATION OF BLITZEN SWAMP & STEIN MT.

— BLITZEN SWAMPS —

Sketch Map

of Reclamation and Irrigation Scheme.

Scale

0 1 2 3 4 5 6 7 Miles

0 1 2 3 4 5 6 7 8 9 10 11 Kilometers